Web-based Collaborative Engineering based on Information Sharing HydroWeb: An Education Experiment in the Internet

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Summary

This paper describes the concept and experiences of the international Open Distance Learning Course 'HydroWeb'. This course deals with the introduction of Web-based Collaborative Engineering in standard education programmes of water related engineering and civil engineering based on information sharing. Organized under the umbrella of IAHR and ETNET21 this course is collaboration from several universities from all over the world. Started in 1999 the course demonstrates the potential and innovative opportunities of Web-Technology in education, research and engineering: Students from the different partner universities form small distributed teams to solve a given engineering problem in a time window of two weeks. To overcome the spatial distribution the students apply modern Web technology such as video conferencing, application sharing and document management. All results as well as the final reports are presented as Web document on a shared Web-based project platform (http://www.hydro-web.org). Besides the experiences to apply standard Web tools and working methods based on information sharing instead the conventional information exchange in the daily engineering work the students improve their soft skills operate successfully in international and interdisciplinary project environments as part of the 'Technical Culture' of nowadays.

1 Introduction

The Internet and the World Wide Web are seen as innovative IC-Technology that offer new opportunities to support civil and hydro-engineering projects using distributed, computer and network based project platforms. Concepts and implementations of such kinds of project platforms are now available. However the application of these solutions and corresponding suitable working processes has yet to be introduced to education and practice in engineering. Working on the World Wide Web, collaboration on projects with colleagues from other disciplines and nationalities as well as sharing information in common working spaces is not only a theoretical matter and a question of software installation and application, but even more a matter of acquisition of experience and the development of a 'Technical Culture' in the engineering society of today. This can only be achieved by practical experiments and exercises. Traditional course programmes in engineering do not cover collaborative engineering. To overcome this gap fifteen universities from all over the world run the course 'HydroWeb: Web-based Collaborative Engineering in Hydroscience' in 2003 for the 5th time as a common distance learning and training course for students and practitioners.

1.1 International Course Framework

Open and distance learning opportunities such as the HydroWeb course can be only developed and performed in an international framework. The course was initiated in 1999 by IHE Delft (NL) and BTU Cottbus (D) and became an essential part of ETNET 21, the European Thematic Network of Education and Training for Environment-Water part of the SOCRATES Programme of the EC. To address students and practitioners world wide the course is also an activity of the professional organisation IAHR (International Association on Hydraulic Research and Engineering) esp. the IAHR-CEPD (Committee on Education and Professional Development) and the IAHR-EGW (Engineering Graduate School Environment Water).

1.2 Course Concept

The idea of the HydroWeb course is simple: Students and practitioners from different locations in Europe are given an engineering task that has to be solved within two weeks by small distributed teams using a shared Web-based team work space. Each team is composed of about eight participants from at least three locations and different disciplines to ensure an international and interdisciplinary collaboration. The teams operate as independent units. The organisational structure, work plan, work distribution and co-ordination inside the teams are defined by the team members themselves. This meant that a team as a whole is responsible for the performance of the given engineering task without any instruction or influence from outside. As opposed to reality in practice, nobody can really lose such a game - the collection of experience by success or failure is always profitable from the point of view of education and training. By 'playing' this game the participants acquire knowledge, experience and competence in Web-based collaborative engineering. They might be better prepared for future challenges: to operate on a global market in international and interdisciplinary project environments and companies.

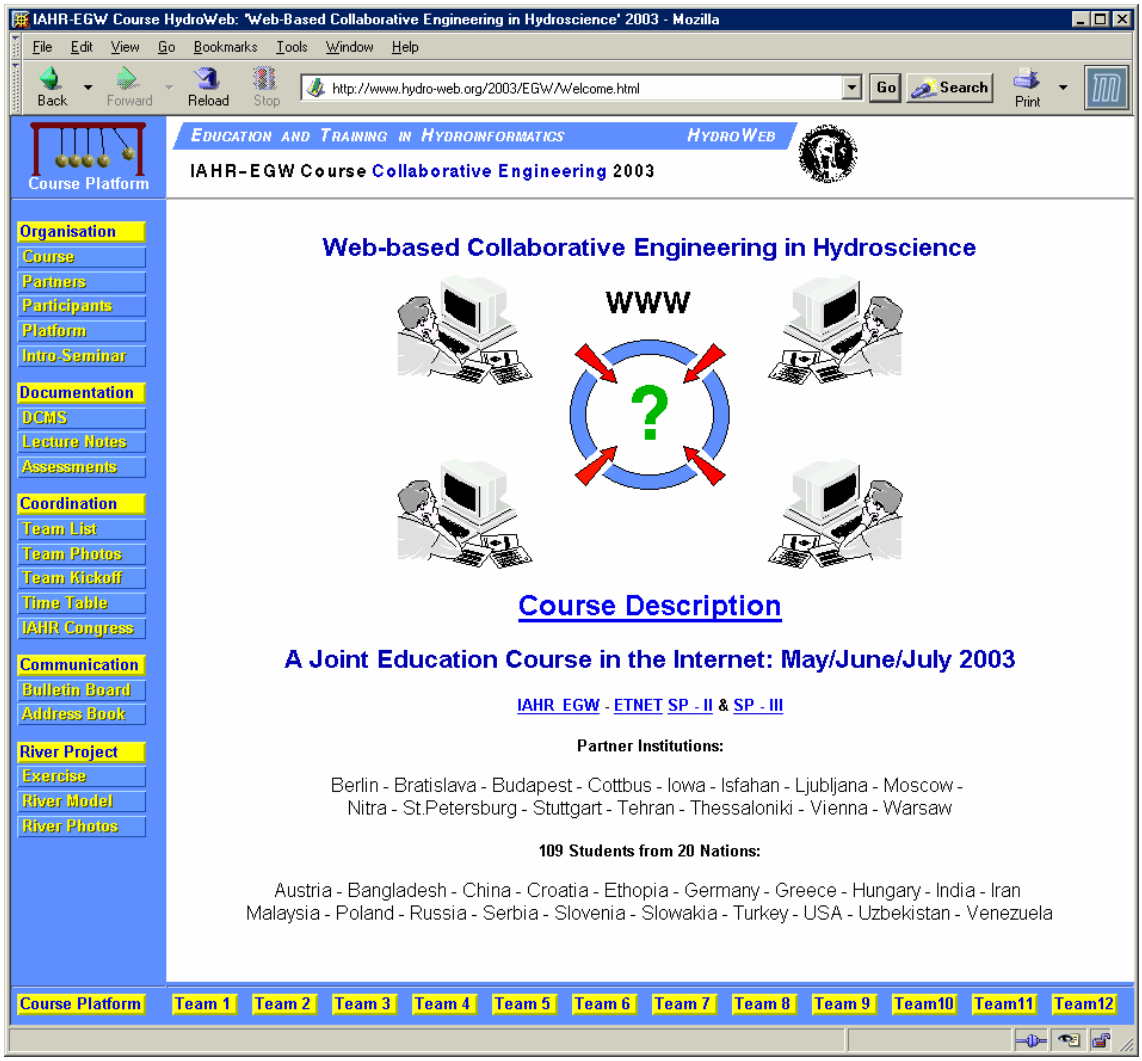


Figure 1: Course Platform

The composition of the 109 participants in 2003 was really heterogeneous: twenty nationalities and an age distribution from 20 to 40 leads to a mixture of different cultural and educational background as well as different habits, languages and social behaviour. Prerequisites for the successful net-based collaboration during the course are elementary skills to operate in the Web

environment, basic knowledge on the theoretical background in hydro-engineering, the ability for creative and responsible engineering and, most importantly, the willingness to co-operate with colleagues from other countries over the Internet. To ensure the equal level of the participants selected lectures were held at all locations in seminars (using distance learning technologies) and common lecture notes were shared in the Internet. In this way the course is a combination of open distance education/training and Web-based collaborative engineering to prepare the participants for Life-Long-Learning and modern engineering.

2 Engineering Task

The engineering task is the design of a flood protection system for a conceptualised river, based on the river Vidå in the south of Denmark. The river discharges into the sea so that tides and surges affect the downstream reaches. The river is highly controlled by weirs, gates and pump stations as well as some limited dredging to protect the river from tides and surges, to ensure the passing of floods from upstream after long rainfall, to manage the polder (køgs, koogs) areas in this region, and to allow navigation with small pleasure craft boats at any time. The objective of the exercise is to introduce structures into the river, with the original data set being given without any structures and some additional boundary conditions (dredging, pumping), to ensure a suitable river management. Boundary conditions were given for a specified time period. This kind of engineering task allows simulating a typical engineering project from practise adapted for the purpose of education/training course.

The engineering task in HydroWeb is typically for river engineering problems. However, it can be easily exchange with similar tasks from other areas of civil, building, water or environmental engineering. In this way HydroWeb could be run for these engineering disciplines and is representative for Web-based Collaborative Engineering courses.

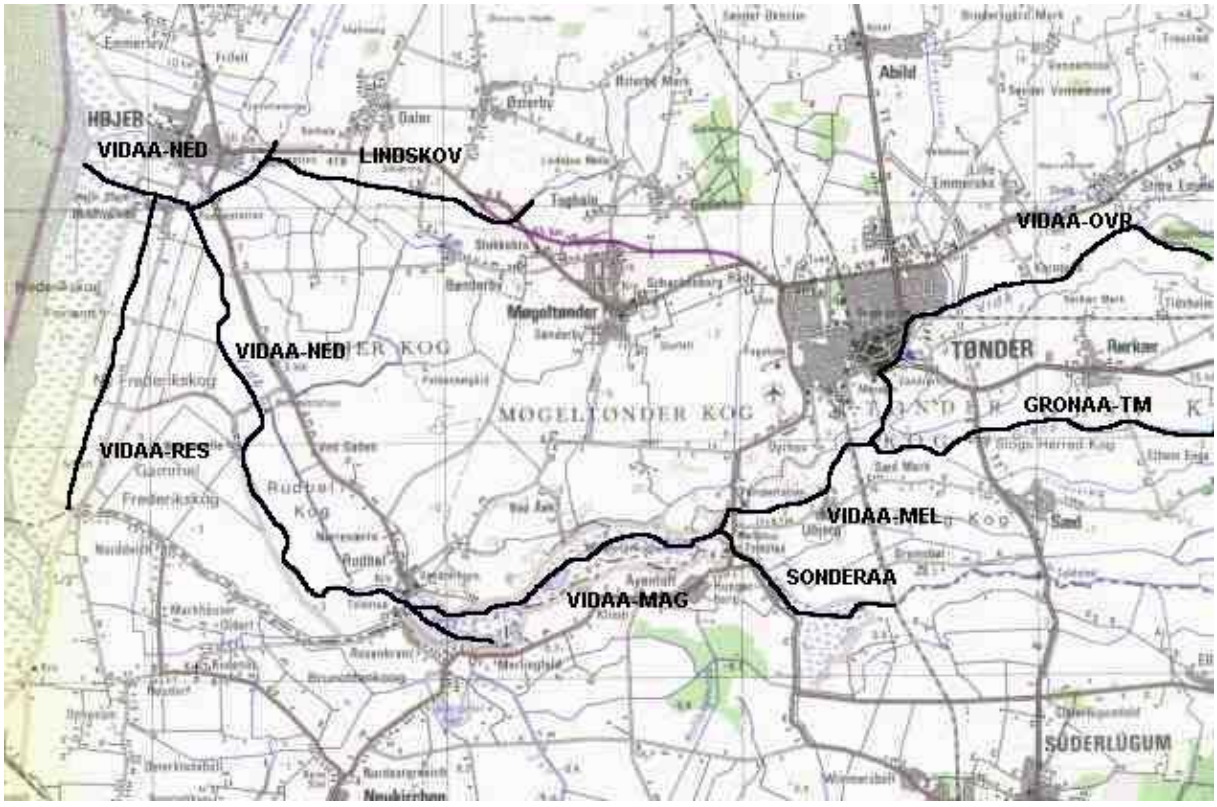


Figure 2: Engineering Task River Vidå

3 Web-based Course Platform

The course platform was designed to overcome the spatial distribution of the participants using available Internet and Web technology to establish a team work space based on information sharing. Local facilities needed are: a standard PC, Internet access and a Web browser. These local facilities are available world wide. The students do not need any special software licenses and can also participate from home with modem, ISDN or DSL access.

The shared facilities supported the collaboration inside the different teams, as well as organisation, observation and advice from the supervisors based on the principle of 'information sharing' in addition to traditional 'information exchange'. The shared facilities were composed of several Web services for each team and the course as whole, accessible for all course participants. The remote, platform independent access to the course platform for information and application sharing is realised by Tarantella. Each team has a login of its own to a Windows 2000 and a Linux server. The file systems of these both servers are the same using Samba. The students can access the team workspace via the Web-Browser or with the free available tarantella client. In this way all team members have access to the same 'team desktop' including the course related engineering software (Mike11). However, the students do not need any model files, documents or application on their own computer: all resources are shared on the server platform, which forced the collaboration within the teams.

All reports and documents of the course are managed by the document management system DCMS (http://dcms.bauinf.tu-cottbus.de) with several group ware functionalities such as document classification, semantic document search, bulletin board, address book and email lists. One (subdirectory) of each team workspace is linked to a Web-Server to publish the team work by Web reports.

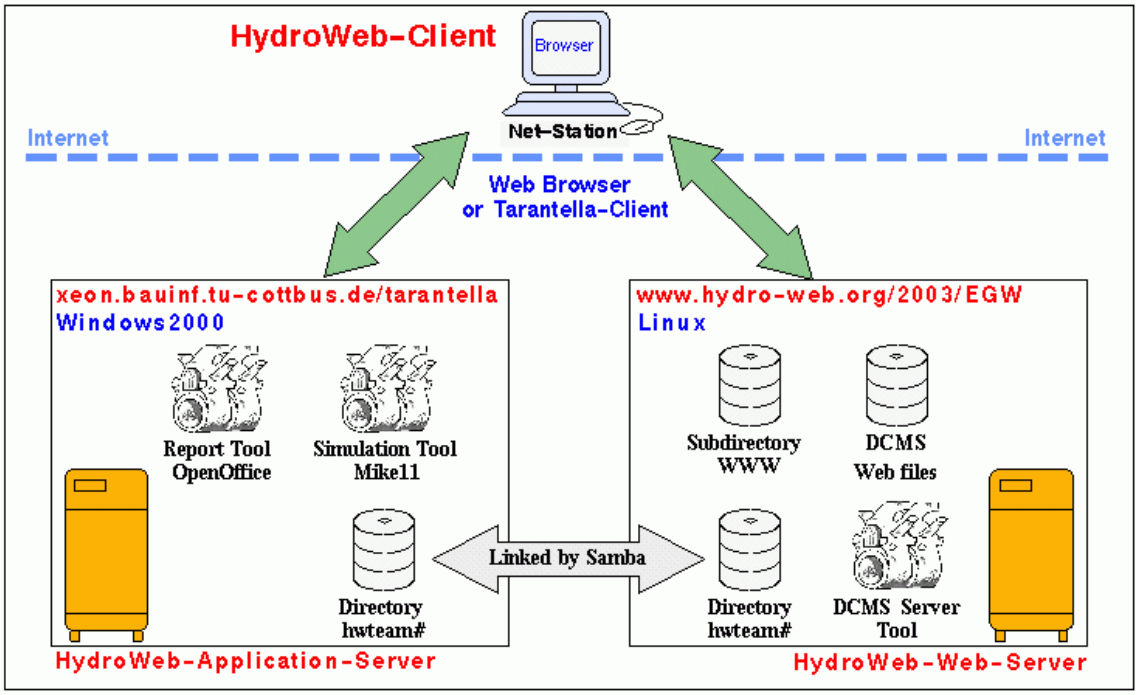


Figure 3: Technical Concept of the Course Platform

Details of the course platform are described in the Web: http://www.hydro-web.org

4 Course Results

The results of the course 2003 will be described as representative for the HydroWeb courses 1999-2003. In 2003 109 students participated from fifteen partner universities setting up twelve teams. All twelve teams delivered their proposed solutions for the given engineering task within the time allowed. The twelve solutions were different in type and in terms of the locations of the river management objects/structures (weirs, dikes, dredging). They demonstrated a range of appropriate engineering alternatives for the management of the (conceptualised) river Vidå. Of course the proposed solutions were not developed in terms of practical designs - the course duration of two weeks was too short to optimise the solutions, especially under economical constraints. Nevertheless, all twelve teams were able to develop a reasonable engineering solution in a short period of time using the World Wide Web as a collaboration platform to overcome the spatial distribution of the participants.

4.1 Engineering Reports

The progress of work during the course and the engineering solutions were documented in shared Web reports by the student teams. Short daily reports from each team contained the current state in the engineering task, and described the work steps, problems, difficulties and exceptions from the work plans, collaboration methods and decisions made by the team. The supervisor's daily assessment commented on the daily progress made by each team and also contained administrative information and hints. Each team produced a final report at the end of the course describing the engineering solution and their collaborative experience. All reports were prepared and distributed as Web documents on the course platform.
(http://www.hydro-web.org/2003/EGW)

4.2 Collaboration Experience

The main target of this education experiment was the acquisition of knowledge and experience in Web-based collaboration. This target was achieved in that all teams gained new experience in applying collaborative Web tools as well as in team work, information sharing, project co-ordination and reporting ('Learning by Doing'). From a technical point of view the facilities provided were appreciated and used between the different locations. Interesting experience was the extension of traditional information exchange tools by information sharing opportunities. Most participants were accustomed to exchange information from one personal working environment to another but not to share information in common working environments.

Email was well known and was therefore used most of the time for news and file exchange. The participants recognised that an email to a single team member (1:1 message) lead to a lack of information for other team members. For this reason they used increasingly the bulletin board facility and mailing lists (1:n message) to share news and the common Web space to share files and documents. In this way they learnt in an intuitive way to apply information sharing with the related problematic nature of access control, joint editing and responsibility.

NetMeeting was used by all of the teams as a general tool for conferencing and discussion. NetMeeting supports audio/video communication for point-to-point connection of two locations. Fascinated by these features the teams started to communicate by this tool. But team members from a third location could not join the conference, so most of the teams used for their shared discussion the chat module and the whiteboard of NetMeeting. This tool allows several team members at different locations to discuss various topics and to save the discussion as HTML protocol for other team members (nxm discussion). Further important feature of NetMeeting for this course was the application sharing module. This allowed partners to share an application over the net. For example, a participant in Isfahan/Iran was able to control a Tarantella desktop with Mike11 application running on the course sever in Cottbus, and to discuss in parallel during a chat session with the other team members in Stuttgart and Moscow

the location of weirs and the impact of the water level. The control of Mike11 can be shifted among the session partners. In this way the teams were able to share information and to discuss them interactively online as a team. Tarantella was successfully used for the remote access to the team workspace with shared file system, shared applications and shared user interface. The teams were forced to develop suitable working methods to coordinate their work and to organize time-shift working and to share of responsibility for the different part of the team platform. This was viewed as an important step compared with the traditional approach of information exchange by file transfer and email.

All teams presented their results in a final report as a Web document. It was the first time that most of the participants had to write a report as a team and as a common Web document. Using the interfaces of standard documentation systems (like OpenOffice, Word) or standard HTML composer (e.g. FrontPage, Netscape Composer) the participants were able to produce a Web report in collaboration (joint editing) and to share it on the Web platform without the additional effort associated with the traditional paper based documentation and information exchange. The document management system provides the students the flexible environment for handling and semantic search of the team reports and to notify the teams for updates and new entries.

Besides this experience in the application of Web tools the participants improved their ability to work as a team in an international environment. Most participants started the project with high motivation and a lot of ideas focused on their individual activity - as they would normally have done in their study exercises. On the second and third day, however, they found out that the other team members at the other locations did not necessarily take up their ideas and approaches - they followed their own ways in parallel or in different directions. There was some disappointment in the teams about ’collaboration’, so they began to communicate and to discuss the different approaches they were using. By the end of the fourth day within the two week course all teams had found by this ’trial and error’ experience a suitable collaboration method including communication rules, co-ordination methods, the specification of responsibilities and the understanding of the different disciplinary views. In this way the teams were able to develop a common team solution for the engineering task and to present it in a common report - not as independent solution and reports from each team member/location.

4.3 Social Aspects

The teams were composed of participants with a heterogeneous background in language, mentality, education, culture, working time and habit. This is representative for an international and interdisciplinary collaboration. The level of competition was low because of the non-existing commercial pressure in educational courses. It was observed that all teams started their communication actively but retained a formal approach to each other. During the two weeks the communication became more and more direct, and included the exchange of personal information such as the exchange of photos of children. A 'course society' arose with typical personal relationships. Insides the teams the members found their roles defined by their competence (e.g. in Web reporting, numerical simulation, project management). They learnt to accept each other's particular competence and to combine their individual abilities towards the common success of the team. The joint work inside the teams led to a better understanding of their different characters and background. In just one week the students acquired a considerable amount of ’social competence’ and ’soft skills’ inside the teams as well as inside the society formed by the whole course. Nevertheless there is one important improvement to be made for the future: a face-to-face meeting of all participants as a kick-off meeting was missing. The net cannot substitute for the personal impressions and relationships of a real face-to-face meeting and the benefits of a social event like a drink and talk at a bar in the evening. This would help to advance the course performance and to set up better understanding inside the teams.

5 Conclusion

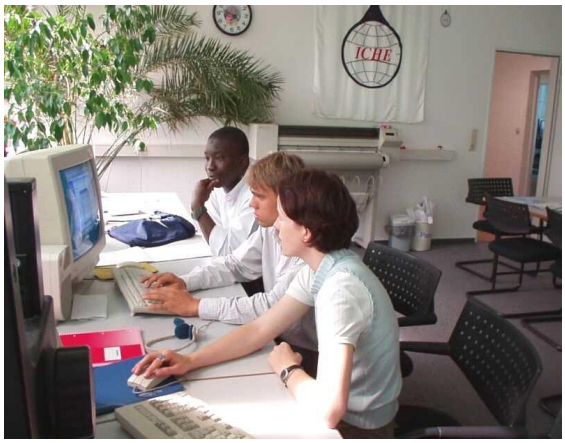
The course as described above is an ambitious educational experiment to extend the normal course programme in engineering by a new topic: Web-based collaborative engineering in international and interdisciplinary projects as open and distance learning opportunity. The effort in terms of preparation and implementation in the past course events was large, and not all of the planned objectives were achieved without problems. However the experiment worked well; in particular the participants were able to work collaboratively via the net beyond all differences in language, nationality, habit, age, culture and educational background. The results and comments of the participants demonstrated the potential and importance of Web-based collaboration for future open and distance education/training in civil, building and environmental engineering.

The important issue has become one of developing a 'Technical Culture', that is, the ability and working methods associated with the application of modern information and communication technologies to distributed project platforms in a beneficial way. The course gave all participants valuable experience in this respect. We believe that such kind of open and distance learning courses will become a standard part of academic and professional education/training programmes in the future as they reflect the progress of the ongoing ICT revolution. Internet based, international and interdisciplinary courses require considerably more effort than traditional courses but there are no alternatives to the acquisition of competence in this field.

The Web-based working platform and the working methods of the education course HydroWeb can be easily applied in practise. Experiences from research and development (R&D) projects shows that the set up, operation and maintenance of the Web-based platform is not a problem any more. The critical hurdles are the soft skills of the involved experts. The changes of working methods and habits from conventional information exchange to information sharing require open mindedness and the willingness to improve and extend personal working methods. Demonstrations and training seminars (Life-Long-Learning) would help to prepare engineers to pick-up the advantages of Web-based Collaborative Engineering and information sharing in practise by a related 'Technical Culture': the transfer of the 'Internet Revolution' to the 'Internet Evolution'.

6 Acknowledgments

The described education experiment was performed 1999-2003 by about 320 students from more than 25 nations and supported by lecturers and technicians from the involved universities and institutions world wide. The enthusiasm of all participants and the close collaboration over the net that went beyond the traditional course programme made this course to an unforgettable event for all 'HydroWeb' experts involved. We thank all the participants for their outstanding engagement and the performance of a real international and interdisciplinary team work.



7 References

HydroWeb Platform: *http://www.hydro-web.org*
DCMS: *http://dcms.bauinf.tu-cottbus.de*